



Back in time to unlock the future: tracing the type-specimens of *Corallus hortulana* (Linnaeus, 1758) (Serpentes: Boidae), with designation of a lectotype for the Amazon tree boa

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Abstract

Corallus hortulana presents a large array of tones and color pattern variability throughout its distribution (= polychromatism), which triggered the description of several taxa now considered to be primary synonyms. Linnaeus described two of these (*Boa enydris* and *Boa hortulana*) on the same page of the 10th Edition of the Systema Naturae. However, both names had been widely used in literature almost in an optional way, until their formal synonymization more than two centuries after the original description. Additionally, the type specimen of *Boa hortulana* was reported as missing since the late 19th century. These two factors may have enabled the unjustified switched association of types, which was perpetuated in the literature to the present day. Our main goals here were to trace the correct type specimens for each species through a literature review and specimen examination, and to amend the switched association of type material. We found two specimens in the collection of the Uppsala University that are unmistakably associated with *Boa hortulana*. Herein we designate one of them as its lectotype in order to promote nomenclatural stability considering its huge phenotypic variability and the future possibility of eventually splitting the species.

Key words: *Corallus enydris*; Linnean types; nomenclatural stability; polychromatism; taxonomic history

Introduction

Corallus hortulana (Linnaeus 1758) [see Frétey (2019) for the combination of Linnean epithets in apposition] is widely distributed in cis-Andean South America, occurring across different vegetation types and elevations from Colombia to southeastern Brazil and eastwards to Surinam and the Brazilian Atlantic Forest (Peters & Orejas-Miranda 1970; Henderson & Hedges 1995; Henderson 1997; Guedes *et al.* 2018; Nogueira *et al.* 2019). The species has an extensive list of synonyms (Fig. 1), in which several species were described based on different morphotypes (McDiarmid *et al.* 1996; 1999; Henderson 1997). Unaware of such variations, Linnaeus (1758) described two forms as two different species: *Boa enydris* Linnaeus, 1758 and *Boa hortulana* Linnaeus, 1758. *Boa enydris* was described based on a single preserved specimen from “America” in Museum de Geer (Carl de Geer) (not illustrated or numbered). *Boa hortulana* was described on the basis of a preserved specimen from “America” in Museum Adolphi Friderici (hereafter *Mus. Reg. Ad. Frid.*) (Linnaeus 1754), and on two figures of Seba (1735, plate 84, fig. 1): “*Coluber de Tlehua seu Igneus perpulcher*” (Fig. 2) and (Seba 1735, pl. 74, fig. 1): “*Vipera paraguajana formosa*”. It is important to highlight that the specimen mentioned by Linnaeus (1754) is the same as Seba’s illustration (1735, pl. 84, fig. 1), since Linnaeus (1758) referred to this specimen twice.

Although some authors (i.e., Shaw 1802; Schlegel 1837) had noticed both Linnean species were actually

synonyms, it was Duméril & Bibron (1844) who first included *Boa enydris* (*lapsus*, written in this way by the authors) and *Boa hortulana* as synonyms of *Xiphosoma hortulanum* Wagler 1824. Despite that, both epithets *enydris* and *hortulana* were continuously used in literature, almost in an alternate way (Fig. 1), until they were formally synonymized and fixed under the name *Corallus hortulanus* by McDiarmid *et al.* (1996). Parallel to the taxonomy, the history of the type specimens has also been rather confusing. The types of *Boa hortulana* were reported as missing (Andersson 1899), and at a given time, the type-specimen of *Boa hortulana* was associated with *Corallus enydris* and the type specimen of *Boa enydris* with *Corallus hortulanus*. This taxonomic mistake has been unnoticed so far and was perpetuated in literature, having the type species for *Corallus enydris* repeatedly attributed to *C. hortulanus* over time.

Given that the type of *Boa hortulana* was considered lost and the switched association of type species remains, our objectives here are (i) to review the literature and related museum collections in order to trace the history of the type species for both Linnean species (*Boa enydris* and *Boa hortulana*); (ii) to correct the putative switched association of type material; (iii) to provide new data on the type specimens of *Boa hortulana*; (iv) to designate a lectotype for *Boa hortulana* in order to promote nomenclatural stability for the species given the high level of polymorphism displayed by the currently recognized *Corallus hortulanus*.

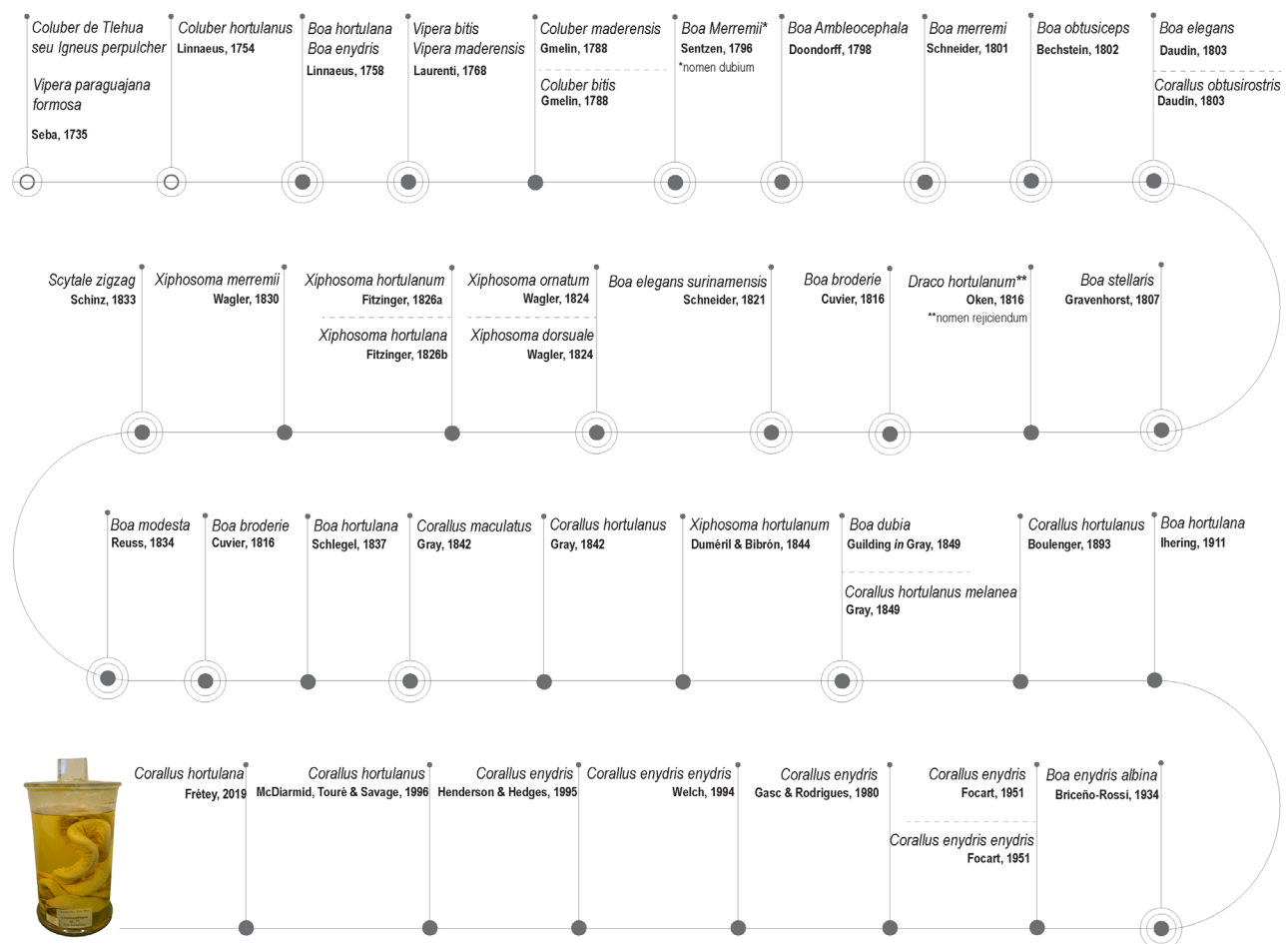


FIGURE 1. Summary of the most important events in the taxonomic history of *Corallus hortulanus*. Legends: white circle = references before the 10th edition of Systema Naturae; double grey circle = pre Linnean species; simple grey circle = new combinations; three grey circle = synonyms.

Material and methods

In order to track the history of the types of *Boa enydris* and *Boa hortulana*, we performed an extensive literature review, which is presented in the results. We also examined the type material housed in Linnaeus' collections in the Swedish Museum of Natural History (Naturhistoriska Riksmuseet, NRM), Stockholm, Sweden and in the Museum of Evolution in Uppsala University (Uppsala Universitet, Evolutionsmuseet, UUMZ), Uppsala, Sweden.

General pholidosis data are presented right/left when necessary. Terminology for cephalic shields and scales follows Henderson (1997), while ventral and subcaudal counts are as defined by Dowling (1951). Sex determination (when possible) was inferred by the size of the cloacal spurs, tail base width and number of subcaudals, since we were not allowed to perform a ventral incision on the tail. We took body measurements (snout-vent length and tail length) with a flexible ruler to the nearest 1 cm, and the head measurements were made with a digital caliper to the nearest 1 mm.

Results

The oldest mentions of *Corallus hortulana* in literature date to Seba's (1735) illustrations: (1735, pl. 84, fig.1) "*Coluber de Tlehua seu Igneus perpulcher*" from "*Nova Hispaniã*" (Fig. 2) and (1735, pl. 74, fig.1): "*Vipera paraguajana formosa*", from "*Americae Meridionalis*" (Fig. 2), and subsequently Linnaeus (1754) who referred to Seba's specimen (1735, pl. 84, fig.1) as *Coluber hortulanus*. However, for taxonomic purposes, the first valid descriptions are from the 10th Edition of the *Systema Naturae* (Linnaeus 1758), although they were based on these same previous studies and specimens. Unaware of the wide morphological variation, Linnaeus (1758) formally described both *Boa enydris* and *B. hortulana* on the same page, and it is worth mentioning that Linnaeus (1758) did not provide any pictures but instead he referred to Seba's illustrations in his descriptions. Also important to this taxonomic history is the description of *Coluber cenchoa* Linnaeus 1758 (= *Imantodes cenchoa*) which was based on a specimen from the *Amoen Acad. I* (p. 306, n. 37) and on two of Seba's illustrations (Seba 1735, pl. 16, figs. 2, 3). Curiously, on this plate (Seba 1735, pl. 16, fig. 1), a specimen of *Corallus hortulanus* was portrayed between two specimens of *Coluber cenchoa* (Fig. 3), and although the figure legend presents the specimens in the direct order (1, 2 and 3) the numbering on the plate is shown in a different order (2, 1 and 3).

In the 19th century, the collections that housed the Linnean types were moved. After the death of Carl de Geer in 1778, his widow donated most of his collection to the Royal Academy of Sciences in Stockholm, Sweden. Not long after, in 1801, Gustav IV Adolph of Sweden divided the Adolphi Friderici Regis' collection between the Royal Academy of Sciences and the University of Uppsala, both also in Sweden (Andersson 1899). Finally, in 1828, the collection of the Royal Academy of Sciences was transformed into the Swedish Museum of Natural History (Kullander 2001).

Duméril & Bibron (1844) made a broad review of the genus *Corallus* and listed *Boa enydris* in the synonymy of *Xiphosoma hortulanum*, with no justification.

Years later, Lönnberg (1896) inventoried the Linnean type specimens at the Uppsala University, and listed three specimens of *Boa hortulana* in the collection: "a large one and two juveniles" [*sic*], not citing any numbers, but referencing to Linnaeus' (1758) notations. He also pointed out these specimens were described in *Mus. Reg. Ad. Frid.* (Linnaeus 1754) and, consequently, they were used in the descriptions of Linnaeus (1758).

Not long after, Andersson (1899) examined the holotype of *Boa enydris* Linnaeus 1758 in the Royal Museum in Stockholm. He provided no numbers, but referred to Linnaeus (1758) and also confirmed its identity by comparing the number of ventral and subcaudal scales with the values provided by Linnaeus (1758). Probably unaware of Lönnberg (1896), he reported the "type specimen" of *Boa hortulana* as missing, but also he mentioned that the jar labeled "*Coluber hortulanus*" contained a specimen of "*Himantodes cenchria*" (= *Imantodes cenchoa*) (Fig. 4). He suggested that either the jar labels could have been swapped or this specimen of "*Himantodes cenchria*" was taken to be a juvenile *Boa hortulana*, and swapped. Either way, the type specimen has not been found. Although merely a supposition, the illustration of Seba (1735, pl. 16) of a specimen of *Corallus hortulana* between two specimens of *Imantodes cenchoa* might have been enough for someone to swap jars or tags, by just comparing the specimens to those pictures which were cited by Linnaeus (1758). Andersson (1899) himself stated Linnaeus did not make those tags, but instead they were made by O. Schwartz (director of the Royal Academy Museum of Sciences from 1806 to 1819) to whom he attributed responsibility for occasional problems in curatorial processes. Additionally, the moving of the collections from one place to another may also have contributed to such problems.

In a checklist of the family Boidae, Stull (1935) argued the position of Linnaeus' descriptions on the page could be used as an argument to establish the priority of *B. enydris* over *B. hortulana*, since the former's description would come first on the page. This act was followed by Forcart (1951), who considered *Corallus enydris* as valid, with two subspecies *C. e. enydris* (including *Boa hortulana* as a junior synonym) and *C. e. cookii*.

Stimson (1969) provided a list that summarized the taxonomic knowledge of the family Boidae at the time. But, assuming the specimen reviewed by Andersson (1899) (now numbered NRM Lin. 7) is the actual holotype of *Boa enydris* according to Linnaeus' (1758) original description, the first switched association of types registered in literature was made by Stimson (1969). When listing the type material, Stimson (1969) pointed out that the holotype of *Boa enydris* was in the Uppsala University (without citing numbers) and also that the "holotype" of *Boa hortulana* was "NRS n° Lin. 7" (*sic*). Actually, this is just the opposite. The holotype of *Boa enydris* is in the Swedish Museum of Natural History, under the number NRM n° Lin. 7, while in the case of *Boa hortulana* there has never been a holotype, but rather syntypes (see Linnaeus 1758). Stimson's study (1969) was not a taxonomic review, so he never designated a lectotype for either species. We believe this switched association of types was merely a mistake that unfortunately has not been observed before and so it was carried on through the years by subsequent authors by citing this source without re-examination of the aforementioned types.

Following Stimson (1969), Schwartz & Henderson (1991) also declared the holotype of *Boa enydris* as "not found". On the other hand, Henderson (1993) cited the actual holotype of *Boa enydris* (NRM Lin. 7) in the synonym list. Probably because, *Boa hortulana* was still considered a junior synonym at the time, its syntypes were ignored.

McDiarmid *et al.* (1996) made a broad review of the taxonomic history of both species. Since the position of descriptions on a page is irrelevant and cannot be taken as criteria for establishing priority of names (ICZN 1999: art. 24), McDiarmid *et al.* (1996) debunked the proposal of Stull (1935), which recognized *Corallus enydris* as the senior species based on the position of Linnaeus' (1758) descriptions, instead they claimed the principle of the first reviser (ICZN 1985: 24), through which they appointed Duméril & Bibron (1844), who recognized *Boa hortulana* as the senior name. Nevertheless, the authors did not mention any type specimens. In the same year, Powell *et al.* (1996), considering the change in nomenclature, but ignoring the switched association of types, relisted the specimen "NRM Lin. 7" as the holotype of *Boa hortulana*.

McDiarmid *et al.* (1999), based on a photograph on the webpage of the Swedish Museum of Natural History (linnaeus.nrm.se/zool/herp/madserp.html), also cited "NRM Lin. 7" as the holotype of *Boa hortulana* Linnaeus, 1758. Consequently, they also supported the switched association and ignored the syntypes of *Boa hortulana* which were presumably lost as declared by Andersson (1899). Nevertheless, the type of *Boa enydris* was never lost (Fig. 5), since it corresponds to the same specimen examined by Andersson (1899).

Wallin (2005) reviewed the Linnean specimens at the Uppsala University collection, and confirmed the same specimens Lönnberg (1896) examined were still there (now numbered UPSZTY 77a, b). However, the switched association of types continued, and was reported, at least, in two studies with taxonomic relevance: Wallach *et al.* (2014) and Reynolds & Henderson (2018). Finally, Uetz *et al.* (2019) cited another specimen as the holotype of *Boa hortulana* (ZMB 1526), which is not related to either of the specimens presented here, but to the iconotype from Merrem (1790, 1821) (*fide* Bauer & Günther 2014).

Since this action was not a nomenclatural act, and type specimens are not changeable (ICZN 1999: art. 61) here we reaffirm the actual type species is *Corallus hortulana* according to McDiarmid *et al.* (1996), the type specimen for *Boa enydris* is located in the Swedish Museum of Natural History (under the number NRM n° Lin. 7), while the syntypes of *Boa hortulana* Linnaeus, 1758 are located in the Uppsala University (see below).

Rediscovery of the types

During a research visit to Uppsala University, we found two specimens of *Boa hortulana* in the Linnean type collection deposited at Evolutionsmusset, Uppsala University [UPSZTY 77a, 77b]. Even though these specimens have been largely ignored, according to their tag numbers, they are the same specimens that were reported by Lönnberg (1896) and Wallin (2005). Therefore, we believe these are the syntypes of *Corallus hortulana* (Linnaeus 1758). Both specimens are very well preserved juveniles. Additionally, the specimen UPSZTY 77b has the belly inflated due to the presence of stomach contents, which was not depicted in the figures of Seba (1735), nor reported by Lönnberg (1896) or Wallin (2005). In the original description of *Boa enydris*, Linnaeus (1758) mentions a single specimen, which corresponds to NRM Lin. 7, therefore this specimen is the holotype of *Boa enydris* Linnaeus, 1758. However, the original description of *Boa hortulana* Linnaeus (1758) mentions a specimen and two of Seba's (1735) illustrations. As Linnaeus (1758) did not choose any specimen to set as a holotype, these are considered syntypes, therefore all have equal status in nomenclature as components of the name-bearing type (ICZN 1999: art. 73).

Seba's (1735, II: p. 84, fig. 1) illustrates an adult specimen with the mouth open (Fig. 2), the same condition found in UPSZTY 77a (Fig. 6), even though the specimen preserves some of the lateral ocelli, the coloration is yellowish due to the fading caused by the long preservation in ethanol. Therefore, to stabilize the nomenclature of the species, we designate herein the UPSZTY 77a as lectotype of *Boa hortulana* (Linnaeus 1758) and the UPSZTY 77b becomes the paralectotype by current designation.

Lectotype. UPSZTY 77a (Fig. 6). Portrayed in Seba (1735, II: p. 84, fig.1), previously confirmed as Linnean type by Lönnberg (1896) and Wallin (2005).

Terra typica. No locality data. [Linnaeus (1758) set the type locality as “America”]. We restrict herein the type locality to cis-Andean South America (ICZN 1999: art. 76), which corresponds to the known distribution of this species.

Description of the lectotype. Subadult male; snout-vent length 960 mm; tail length 283 mm; head width 19.55 mm; head length 33.91 mm; head height 10.84 mm; eye-rostral distance 13.55 mm; distance between eyes 12.62 mm; nostril-rostral distance 2.08 mm; eye-mouth distance 3.55 mm; distance between nostrils 5.00 mm; loreal 2/2, infraloreals 1/1; supralabials 13/13; circumorbitals 14/14; infralabials 18/18; intersupraoculars 10; dorsal scale rows 37/52/27; preventral 1; ventral scales 273; subcaudal scales 119, cloacal plate single. Coloration in 70% ethanol. The specimen has lost its original coloration and pattern due to the long preservation time. Current general color is faded yellow.

Description of paralectotype. Subadult female; snout-vent length 723 mm; tail length 183 mm; head width 13.92 mm; head length 24.08 mm; head height 9.62 mm; eye-rostral distance 9.24 mm; distance between eyes 9.12 mm; nostril-rostral distance 1.42 mm; eye-mouth distance 2.04 mm; distance between nostrils 3.98 mm; loreal 2/2, infraloreal 3/3; supralabials 14/14; circumorbitals 15/15; infralabials 18/19; intersupraoculars 13; dorsal scale rows 38/55/29; preventral 1; ventral scales 277, subcaudal scales: 150+1; cloacal plate single. Coloration in 70% ethanol, faded as the lectotype. This specimen has a large food item in the stomach, making its body quite bulky in the corresponding region.

Discussion

Until recently, the type material of *Boa hortulana* was considered missing, and the holotype of *Boa enydris* has inadvertently taken its place in literature since Stimson (1969). Using literature to track back the history along with the examination of type material for both, *Boa hortulana* and *Boa enydris*, permitted us to find the syntypes of the former and designate its lectotype to finally clarify the mistaken association of types perpetuated through the years. Missing or lost types are not uncommon (Taylor 1944; Wallach *et al.* 2014). Changes in collections, of storage facilities, deficiencies in curatorial management, abandonment, natural or unpredicted disasters, and even wars have been responsible for the disappearance of many types over time (Lönnberg 1896; Kullander 2001; Wallin 2005; Wallach *et al.* 2014; Uetz *et al.* 2019). The designation of lectotypes does not constitute an end in itself and such procedure is not recommended in many instances as a general practice (ICZN 1999: art. 74). However, in cases where there are taxonomic and/or nomenclatural problems the unambiguous association of a given name with an onomatophore is essential (ICZN 1999; Daston 2004; Dubois 2017; David *et al.* 2011; Uetz *et al.* 2019). The case treated here was not due to an ultimate loss, actually the types of *Boa hortulana*—allegedly disappeared by means of a change in address or curatorial management (Kullander 2001)—were never lost or missing (see Lönnberg 1896; Wallin 2005). Possibly, the confusion of using the names *Corallus hortulana* or *Corallus enydris* over time ended up creating this bleak scenario with respect to each type material. Nevertheless, none of the studies examined here formally proposed a change of types, but only perpetuated Stimson's (1969) mistake for decades. More importantly, *Corallus hortulana* represents a species complex currently under review (Gonzalez 2014). As the taxonomy of this group of snakes is in state of flux and species boundaries are still widely unknown (Duarte *et al.* 2015), the designation of a lectotype is important to stabilize the nomenclature with a name-bearing specimen. Linnaeus' descriptions were brief and provide only a few characters (i.e., ventrals, subcaudals, and general coloration) if compared to the amount of characters we use nowadays for delimiting snake species, which justifies its redescription (Uetz *et al.* 2019). Therefore, the correct association of each of the types makes any future taxonomic decision straightforward in the case of recognition of hidden diversity in *Corallus hortulana*.



B



FIGURE 2. Adapted illustrations from Seba (1735, II: p. 84. fig. 1), on which Linnaeus based his descriptions in 1758: a) *Coluber de Tlehua seu Igneus perpulcher* (p. 84. fig. 1). The specimen presents the mouth slightly open, the same condition found in the lectotype designed here; b) *Vipera paraguajana formosa* (p. 74. fig.1).



FIGURE 3. Illustrations of Seba (1735, II: plate 16), showing a specimen of *Corallus hortulanus* between two specimens of *Imantodes cenchoa*.



FIGURE 4. *Coluber hortulanus* (*Imantodes cenchoa*). Specimen preserved in the collection of the Swedish Museum of Natural History (Naturhistoriska Riksmuseet, NRM), Stockholm, Sweden. The presence of this specimen in the jar is probably a result of a curatorial mistake (see Andersson 1899). Total length = 600 mm (Andersson 1899). Photograph from the NRM webpage, available on <linnaeus.nrm.se/zool/herp/madserp.html.en>.



FIGURE 5. The holotype of *Boa enydris* Linnaeus 1758 (NRM Lin. 7), housed in the collection of the Swedish Museum of Natural History (Naturhistoriska Riksmuseet, NRM), Stockholm, Sweden. Total length = 1275 mm (Andersson 1899). Photograph by Bodil Kajrup.



FIGURE 6. Lectotype of *Boa hortulana* Linnaeus 1758 [UPSZTY 77a]: views of the head: a) dorsal, b) lateral, c) ventral, d) general dorsal view, e) general ventral view. Photographs: Thaís Guedes.

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